**Roanoke River TMDL Implementation Plan**
**Best Managment Practice Efficiency and Costs**

August 20th, 2014

| Stormwater BMP - Residential/Urban | Sediment Removal Efficiency (%) | Bacteria Removal Efficiency (%) | Cost (per acre treated unless otherwise noted) | Efficiency Source | Cost Source |
|---|---|---|---|---|---|
| Rain Barrel | 6% | NA | $150 | Linking Local TMDLs to the Chesapeake Bay TMDL in the James River Basin | James River IP |
| Permeable Pavement | 80% | N/A | $240,000 | Virginia Stormwater Management Handbook | Hagan and King, 2011. Costs of Stormwater Management Practices in Maryland Counties. Prepared for Maryland Department of the Environment |
| Infiltration Trench | 75% | 90% | $6,000 | TSS - Virginia Stormwater Management Handbook; Bacteria - US EPA | James River IP |
| Bioretention | 70% | 90% | $10,000 | TSS - Virginia Stormwater Management Handbook; Bacteria - US EPA | Cooks Creek and Blacks Run IP |
| Rain Gardens | 70% | 70% | $5,000 | Hunt, William F, Jonathan T Smith, and Jon Hathaway. City of Charlotte Pilot BMP Monitoring Program , Mal Marshall Bioretention Final Monitoring Report. City of Charlotte, 2007. | Cooks Creek and Blacks Run IP |
| Vegetated Swale | 65% | 0% | $18,150 | Virginia Stormwater Management Handbook | Center for Watershed Protection Urban Stormwater Retrofit Practices |
| Constructed Wetland | 50% | 80% | $2,900 | Virginia Stormwater Management Handbook | Center for Watershed Protection Urban Stormwater Retrofit Practices |
| Manufactured BMPs | 80% | 80% | $20,000 | VA Spout Run TMDL IP | VA Spout Run TMDL IP |
| Wet Pond | 50% | 70% | $8,350 | Virginia Stormwater Management Handbook | Center for Watershed Protection Urban Stormwater Retrofit Practices |
| Detention Pond | 50% | 30% | $3,800 | Virginia Stormwater Management Handbook | Center for Watershed Protection Urban Stormwater Retrofit Practices |
| Riparian Buffer: Forest | 70% | 57% | $3,500 | Virginia TMDL IP Manual | Moores Creek IP |
| Riparian Buffer: Grass/Shrub | 50% | 50% | $360 | Virginia TMDL IP Manual | Blacks Run and Cooks Creek TMDL IP (2006) |
| Street Sweeping | Variable based on type of sweeping | 5.50E+08 | $40 per curb mile | South Christinans IP | Schilling, J.G. 2005. Street Sweeping – Report No. 1, State of the Practice. Prepared for Ramsey- Washington Metro Watershed District (http://www.rwmwd.org). North St. Paul, Minnesota. June 2005. |
| Urban Landuse Conversion | LU Conversion | LU Conversion | $3,500 | NA | Spout Run TMDL |
| Stream Restoration | 310 lbs/ft/year | N/A | $300 | Stakeholder Input | Stakeholder Input |

| Residential BMPs | Sediment Removal Efficiency (%) | Bacteria Removal Efficiency (%) | Cost (per system) | Efficiency Source | Cost Source |
|---|---|---|---|---|---|
| Septic System Pump-Out (RB-1) | N/A | 5% | $300 | Virginia DCR TMDL IP Manual | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Sewer Connection (RB-2) | N/A | 100% | $9,500 | Removal Efficiency is defined by practice | Western Virginia Water Authority |
| Repaired Septic System (RB-3) | N/A | 100% | $3,600 | Removal Efficiency is defined by practice | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Septic System Installation/Replacement (RB-4) | N/A | 100% | $6,000 | Removal Efficiency is defined by practice | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Alternative Waste Treatment System Installation (RB-5) | N/A | 100% | $16,000 | Removal Efficiency is defined by practice | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Pet Waste Management Program | N/A | 25% | $5,000 | Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp. | Darden Mill Run, Mill Swamp, and Three Creek TMDL IP/Upper York River Basin IP |
| Pet Waste Station | N/A | Part of Pet Waste Management Program | $4,070 | | Cost includes intial unit and five years worth of bag and trash can liner refills (James River Association) |

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| Agricultural BMP - Livestock Exclusion/Manure Management | Sediment Removal Efficiency (%) | Bacteria Removal Efficiency (%) | Cost (per system) | Efficiency Source | Cost Source |
|---|---|---|---|---|---|
| CREP Livestock Exclusion (CRSL-6) | 56 | 100 | $19,000 | Moores Creek IP (Sediment), Removal Efficiency is defined by practice (Bacteria) | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T) | 56 | 100 | $21,000 | Moores Creek IP (Sediment), Removal Efficiency is defined by practice (Bacteria) | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Small Acreage Grazing System (SL-6AT) | 56 | 100 | $9,000 | Moores Creek IP (Sediment), Removal Efficiency is defined by practice (Bacteria) | *Smith-Mayo IP |
| Livestock Exclusion with Reduced Setback (LE-2T) | 56 | 100 | $17,000 | Moores Creek IP (Sediment), Removal Efficiency is defined by practice (Bacteria) | *Smith-Mayo IP |
| Stream Protection/Fencing (WP-2T) | 56% | 100% | $21,000 | Moores Creek IP (Sediment), Removal Efficiency is defined by practice (Bacteria) | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Manure Storage (WP-4) - Dairy | NA | 80% | $100,000 | VirginiaTMDL IP Manual | Virginia Agricultural BMP Database |
| Manure Storage (WP-4) - Beef | NA | 80% | $58,000 | Virginia TMDL IP Manual | Virginia Agricultural BMP Database |

| Agricultural BMP - Pasture | Sediment Removal Efficiency (%) | Bacteria Removal Efficiency (%) | Cost (per acre) | Efficiency Source | Cost Source |
|---|---|---|---|---|---|
| Vegetative Cover on Critical Areas (SL-11) | 75% | 75% | $1,200 | Virginia TMDL IP Manual | Virginia Agricultural BMP Database |
| Reforestation of Erodible Pasture (FR-1) | LU Conversion | LU Conversion | $560 | Virginia TMDL IP Manual | Virginia Agricultural BMP Database |
| Pasture Management (EQIP 528, SL-10T) | 30% | 50% | $75 | USEPA-CBP, Nonpoint Source Best Management Practices used in Scenario Builder for Phase 5.0 of Chesapeake Bay Watershed Model | NRCS and DCR incentive based practices |
| Wet Detention Ponds for Pastureland | 80% | 80% | $150 | Virginia Stormwater Management Handbook | Lower Banister River IP |

| Agricultural BMP - Cropland | Sediment Removal Efficiency (%) | Bacteria Removal Efficiency (%) | Cost (per acre) | Efficiency Source | Cost Source |
|---|---|---|---|---|---|
| Continuous No-Till (SL-15) | 70% | 70% | $100 | Virginia TMDL IP Manual (Bacteria based on Sediment Reduction - same methodology in South Christians IP) | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Small Grain Cover Crop (SL-8) | 20% | 20% | $30 | Nonpoint Source BMPS approved for Phase 5.0 of the Chesapeake Bay Program Watershed Revised 1/18/06. | Virginia Agricultural BMP Database (Average of Upper Roanoke BMPs) |
| Permanent vegetative cover on cropland (SL-1) | 75% | 75% | $175 | Virginia TMDL IP Manual | Virginia Agricultural BMP Database |
| Sod Waterway (WP-3) | 50% | 50% | $1,600 | Virginia TMDL IP Manual | Virginia Agricultural BMP Database |
| Cropland Buffer/Field Borders (CP-33 and WQ-1) | 50% | 50% | $600 | Virginia TMDL IP Manual | |